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Uncommon Anatomical Variants of the Dural Venous Sinuses: A Case Series Highlighting Diagnostic Pitfalls in MR Venography

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Abstract

Background: Recognizing normal variants of the dural venous sinuses is essential to avoid misdiagnosing them as pathology, particularly venous sinus thrombosis.

Aim of Study: To present a series of uncommon anatomical variations of the dural venous sinuses observed on MR venography that were initially suspected to represent vascular pathology.

Patients and Methods: From a larger cohort of patients undergoing MR venography, we present seven selected cases that demonstrated rare anatomical variants mimicking vascular pathology. Imaging was performed using a 1.5 Tesla MRI scanner with 3D MRV and conventional MRI sequences.

Results:

- Case 1: Hypoplastic left transverse and sigmoid sinuses mimicking left-sided thrombosis.
- Case 2: Aplasia of the anterior one-third of the superior sagittal sinus with compensatory bilateral cortical drainage.
- Case 3: Bifurcated superior sagittal sinus simulating venous duplication or thrombus.
- Case 4: Bilateral persistent occipital sinuses associated with transverse sinus aplasia.
- Case 5: Persistent anterior falcine sinus mimicking an enhancing interhemispheric mass.
- Case 6: Persistent falcine sinus associated with aplastic straight sinus.
- Case 7: Aneurysmal dilatation of the torcular herophili mimicking vein of Galen malformation.

Conclusion: Understanding and identifying anatomical variants of the dural venous sinuses on MR venography is critical to prevent misinterpretation and unnecessary interventions. MRV readers should be aware of these patterns to distinguish them from true vascular pathologies.

Key Words: *MR venography – Dural venous sinuses – Anatomical variants – Venous thrombosis mimic – Neuroimaging – Falcine sinus – Torcular herophili.*

Introduction

THE group of sinuses known as the dural venous sinuses is responsible for draining venous blood from the cranial cavity. It refills the heart with deoxygenated blood for systemic circulation. Within the cranial cavity, between the periosteal and meningeal layer of the dura mater, are seven primary dural venous sinuses: The superior, inferior, straight, transverse, sigmoid, cavernous, and superior petrosal sinuses. The majority of them are located close to the tentorium cerebelli and falx cerebri **[1,2]**.

The superior and inferior sagittal sinuses, the straight, transverse, sigmoid, occipital, cavernous, inter-cavernous, superior and inferior petrosal, spheno-parietal, and marginal sinuses, as well as the basilar plexus, are among the main dural venous sinuses **[2]**. The dural venous system may exhibit a number of changes as a result of its complex

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Abbreviation Full Term:

MRV : Magnetic Resonance Venography.
MRI : Magnetic Resonance Imaging.
T1WI : T1-Weighted Imaging.
T2WI : T2-Weighted Imaging.
FLAIR : Fluid Attenuated Inversion Recovery.
SSS : Superior Sagittal Sinus.

texture **[2].** Multiple variants can arise from a vast venous network that gives rise to the dural venous sinuses. Interventional neurosurgery procedures may become more complex as a result of misdiagnosisand inadequate awareness about these variances. For this reason, it's critical to comprehend both the variant anatomy and the anatomy of the dural sinuses as they present in their most consistent manner **[3,4].**

The confluence of sinuses, or torcular herophili, is the point where the superior sagittal sinus, transverse sinus, occipital sinus, and straight sinus join **[5].** An essential tool for researching the normal variations and anatomy of the cerebral venous system is magnetic resonance venography (MRV) **[1].**

This case series highlights key anatomical variations encountered during MRV interpretation in clinical practice that initially mimicked disease.

Patients and Methods

Case Presentations:

- Case 1: *Hypoplastic Left Transverse and Sigmoid Sinuses:*

A 36-year-old female with chronic headache underwent MRV. Imaging revealed hypoplastic left transverse and sigmoid sinuses. There was no signal dropout or collateralization to suggest thrombosis. Recognized as a normal variant. (Fig. 1).

- Case 2: *Aplasia of Anterior Superior Sagittal Sinus:*

A 27-year-old male referred for suspected sagittal sinus thrombosis. MRV showed complete aplasia of the rostral SSS with bilateral compensatory frontal cortical vein drainage. (Fig. 2).

- Case 3: *Bifurcated Superior Sagittal Sinus:*

In this case, the superior sagittal sinus appeared bifurcated on axial T2WI and MRV, forming two separate branches draining into both transverse sinuses without forming a true torcular confluence. No pathology was detected. (a,b,c) Arrows illustrate a bifurcated superior sagittal sinus in axial T2 WI. These did not form the sinus confluence; instead, they coursed as two distinct branches that drained into the transverse sinus. (Fig. 3).

- Case 4: *Bilateral Persistent Occipital Sinuses:*

An adolescent male showed bilateral persistent occipital sinuses on MRV, associated with hypoplastic left and aplastic right transverse sinuses. Initially misinterpreted as dilated venous collaterals. (Fig. 4).

- Case 5: *Persistent Anterior Falcine Sinus:*

A 25-year-old patient with a suspected midline mass was found to have a persistent anterior falcine sinus on FLAIR and post-contrast imaging, draining into the inferior sagittal sinus. No mass was present. (a) Axial FLAIR WI showed a well-defined anterior falcine interhemispheric mass eliciting high signal (arrow); (b) the lesion appears as a tubular vividly enhancing vascular structure draining into the inferior sagittal sinus (Chevron) on sagittal post-contrast T1 WI; (c) the MRV study shows the previously mentioned enhancing sinus is hardly depicted. (Fig. 5).

- Case 6: *Persistent Falcine Sinus with Aplastic Straight Sinus:*

Two pediatric patients had persistent falcine sinuses in the absence of cranial anomalies. One had an associated aplastic straight sinus. These were identified as fetal venous channels that persisted beyond infancy. (a) persistent falcine sinus (arrow) visible on sagittal T2 WI.

- Case 7: *Aneurysmal Dilatation of the Torcular Herophili:*

One pediatric patient showed aneurysmal enlargement of the torcular herophili without features of a vein of Galen malformation or venous thrombosis. Maintained signal void helped avoid misdiagnosis. (Fig. 7).

This study was conducted in Kasr Al-Ainy, Radiology Department from Jan. 2020 – Jan. 2025.

Fig. (1): Hypoplastic Left Transverse and Sigmoid Sinuses.

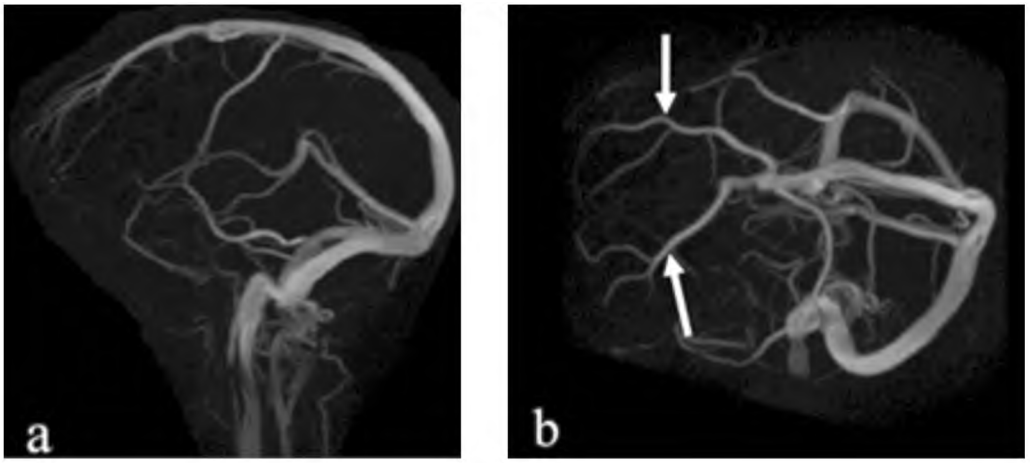

Fig. (2): Aplasia of Anterior Superior Sagittal Sinus.

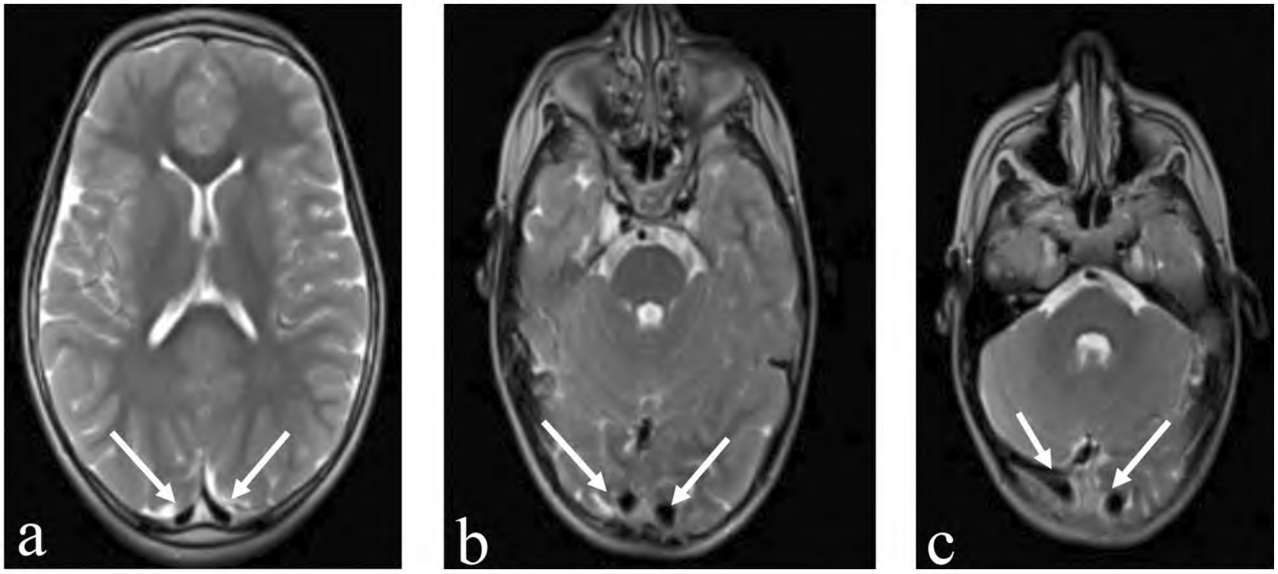

Fig. (3): Bifurcated Superior Sagittal Sinus.

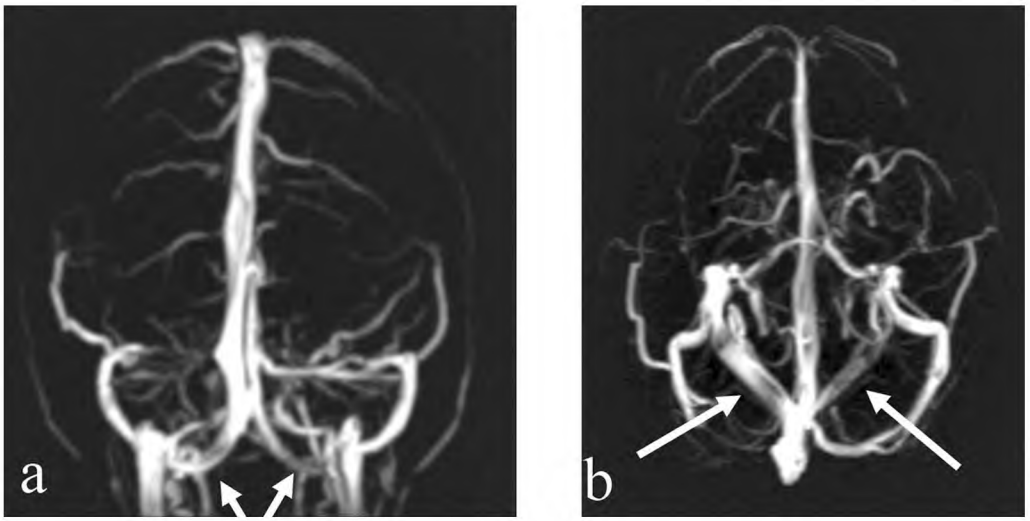

Fig. (4): Bilateral Persistent Occipital Sinuses.

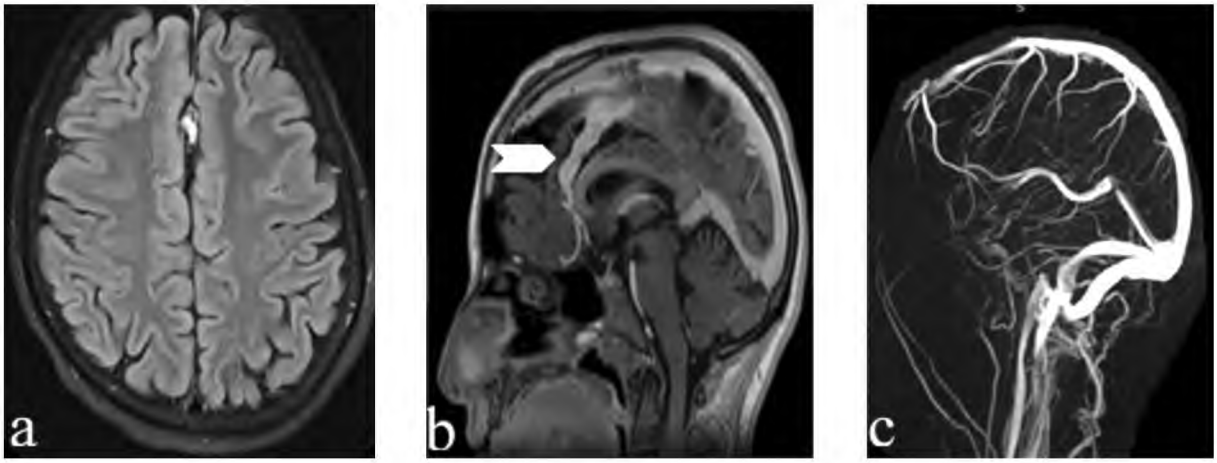

Fig. (5): Persistent Anterior Falcine Sinus.

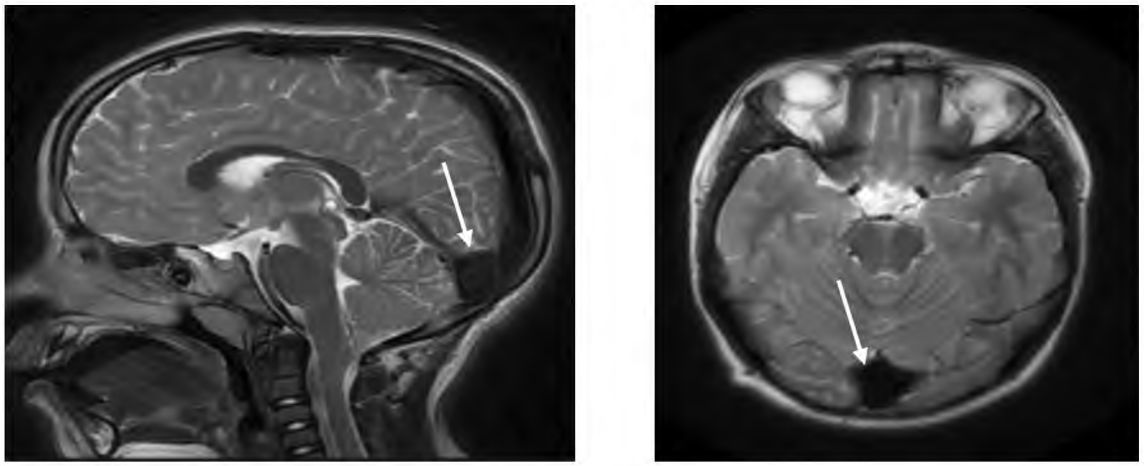

Fig. (6): Persistent Falcine Sinus with Aplastic Straight Sinus.

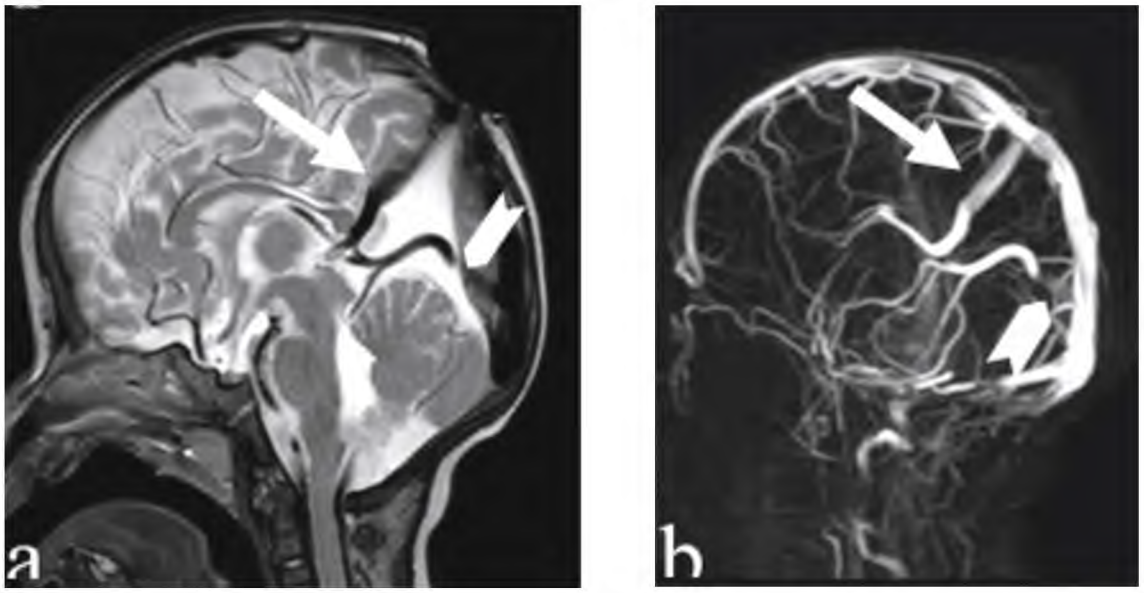

Fig. (7): Aneurysmal Dilatation of the Torcular Herophili.

Discussion

As we mentioned before, it is essential to detect dural venous sinuses' normal variants to avoid misdiagnosing them as abnormal pathological findings that warrant intervention.

We detected a pediatric individual with aneurysmal dilatation of the torcular herophili, which had been mistakenly identified as a malformation of the vein of Galen. However, there was no sign of feeding arteries or draining veins to support this diagnosis. Saglam M et al., [6] stated that torcular herophili aneurysmal dilatation is an extremely uncommon condition that shouldn't be considered abnormal. Radiological differential diagnosis includes meningioma, sinus thrombosis, vein of Galen malformation, and dural arteriovenous fistula. The lack of draining veins or feeding arteries, as well as the homogenous post-contrast enhancement, could distinguish this from those possibilities.

One patient we identified had bilateral occipital venous sinuses, associated with hypoplastic left transverse and aplastic right transverse venous sinuses, that were misinterpreted as large venous collaterals. This matches Das AC and Hasan M [7] findings that occipital venous sinus could be a single or duplicated. Its presence is often associated with hypoplastic or absent transverse sinuses.

N Surendrababu et al., [8] described variations in the straight sinus, such as hypoplasia, aplasia, or duplication. A persistent falcine sinus is typically detected when the straight sinus is absent. One of the cases in our study had a persistent falcine sinus in place of a straight sinus aplasia.

The superior sagittal sinus receives the drainage from the deep cerebral venous system through the falcine sinus, a typical fetal structure found inside the falx cerebri. It typically involutes after birth. The anterior portion of the straight sinus or the vein of Galen is the source of the falcine sinus, which drains into the superior sagittal sinus [9].

We found one case of persistent falcine vein in a child in our study, which had been misdiagnosed as an enlarged venous collateral without vein of Galen malformation, cranial anomalies (atretic cephalocele), or venous thrombosis. A case of persistent anterior falcine sinus that resembled an anterior interhemispheric mass lesion was revealed to be a venous channel draining into the inferior sagittal sinus after contrast enhancement.

Our cases meets the findings of Strub WM, et al., [9] and Ryu CW [10], stating that an anomalous venous structure in the anterior falx that drains the inferior sagittal sinus into the superior sagittal sinus has been documented by the same name. In 2-5% of people, falcine sinus is present after birth [9]. Adults with persistent falcine sinus typically have it alone, without any further cranial anomalies. It is also the most frequent venous anomaly in children associated with atretic cephaloceles or a vein of Galen aneurysmal malformation.

Each case in our case series illustrates a distinct normal variation of the dural venous sinuses that may be misread as disease. Awareness of such variations is vital for neuroradiologists and clinicians interpreting MRV studies. Correct identification prevents misdiagnosis and unnecessary treatment, particularly anticoagulation.

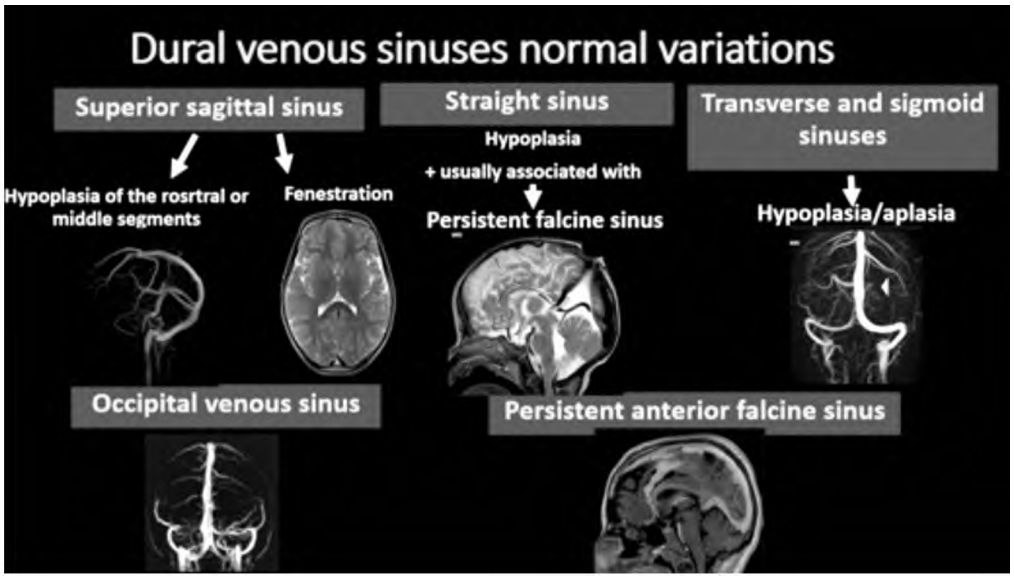

Fig. (8): The different normal variations of the dural venous sinuses in our study are depicted in this illustrative image.

Conclusion:

Uncommon anatomical variants of the dural venous sinuses may mimic vascular pathology. Careful evaluation of MRV findings with an understanding of normal variants can aid in avoiding diagnostic errors.

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المتغيرات التشريحية غير الشائعة للجيوب الوريدية الجافية: سلسلة حالات تسلط الضوء على المزالق التشخيصية في التصوير الوريدى بالرنين المغناطيسى

إن التعرف على المتغيرات التشريحية الطبيعية للجيوب الوريدية الجافية أمر بالغ الأهمية لتجنب تشخيصها بشكل خاطئ كحالات مرضية، وخصوصًا خثار الجيوب الوريدية.

الهدف من البحث هو عرض سلسلة من المتغيرات التشريحية غير الشائعة للجيوب الوريدية الجافية كما ظهرت فى تصوير الرنين المغناطيسى الوريدى، والتى أُسيء تفسيرها فى البداية على أنها أمراض وعائية.

من مجموعة أكبر من المرضى الذين خضعوا لتصوير الرنين المغناطيسى الوريدى، تم اختيار سبع حالات أظهرت متغيرات تشريحية نادرة تحاكى أمراضًا وعائية. تم إجراء التصوير باستخدام جهاز رنين مغناطيسى بقوة ١,٥ تسلا مع تقنيات MRV ثلاثية الأبعاد وتسلسلات تقليدية للتصوير بالرنين المغناطيسى.

إن فهم وتحديد المتغيرات التشريحية للجيوب الوريدية الجافية في تصوير الرنين المغناطيسى الوريدى أمر بالغ الأهمية لتفادى التفسيرات الخاطئة والتدخلات غير الضرورية.